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A PERIODICAL SURVEY OF NEW DEVELOPMENTS IN THE TREATMENT OF PESTS, DISEASES AND WEEDS

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EDITORIAL

THE rate of development of modern fungicides has for a long time been outstripped by that of modern insecticides. Readers should, therefore, find of special interest in this number of the *Plant Protection Overseas Review* two articles on modern fungicides dealing respectively with the search for such products based on organic compounds to replace those based on copper, and with the urgent demand for more effective fungicides than those hitherto employed in the fight against apple and pear scab.

We also welcome an article on the life history of and the protective measures used against the destructive mealy bug of vines in Egypt and a contribution, republished by kind permission of the Editor of *Agricultural Progress*, on the subject of dangerous chemicals and the proper methods of using them. Although this article was written over a year ago and some of its statements must, therefore, be modified in the light of recent events, the main theme is still of considerable relevance to, and importance in, present day practice.

SAFE METHODS OF USING DANGEROUS CROP PROTECTION CHEMICALS

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MY colleague, Mr. Cronshey, has outlined in a previous paper the developments which have taken place in the last decade or so in chemical insecticides, fungicides and weed-killers. I want to refer more particularly to those regarded as dangerous to man.

At the outset may I make it quite clear that I am not a medical man. On this question of the safe handling of dangerous chemicals I speak solely as an agricultural chemist who, for upwards of twenty-five years, has been directly and intimately connected with the development of the use of chemicals useful in world agricultural practice.

It is important, I think, to get the whole subject in proper perspective. If you examine the vital statistics in this country, or any country, you may be surprised to find that water and coal gas are probably two of the most dangerous chemicals. Similarly, petrol is the motive power of many millions of motor cars and is, therefore, indirectly the cause of a lamentably tremendous death-roll; yet no one would seriously suggest that we could or should do without any of these commodities.

Dr. Barnes, of the Medical Research Council, to whom I shall refer again later, has recently said that it has been suggested in America that more workers die from mechanical injury sustained when applying crop protection chemicals than from poisoning by them. In this country, he adds, the number dying from this latter cause in any one year is probably smaller than those killed by bulls, and none occurred in the past season.

Despite cultural and biological methods of controlling the insects, fungi and weeds which damage our crops, few would seriously deny that we must use crop protection chemicals if we are to feed the world's increasing population. It is true that we are striving continuously to find safer products but, for the time being, some that are intrinsically dangerous must be used. *It is up to us to find the safest possible ways of handling them.*

Many mistaken and exaggerated statements are made on this subject. In lighter vein, may I tell you that within a relatively few months of my own Company placing an organo-mercury seed dressing on the market in 1932, we heard of a serious complaint from an estate owner here in the west country that the use of this dressing on seed corn had caused the deaths of many game birds. One of my colleagues went some days later to investigate the allegation and was met by an irate farm manager with the statement that he was so-and-so certain that our product had caused the damage. He had had a post-mortem conducted on the birds and found the *arsenic !* Similarly, in those early days we had a case in Berkshire where we were accused of killing a large portion of a pack of foxhounds; they had run across a field planted with oats dressed with the same organo-mercury dressing. On that occasion I went to great pains to demonstrate that even if a single hound had dug up every seed in the field and swallowed it, and if the grain had retained the whole of its original coating of dressing, the amount of mercury present could not conceivably have killed that single hound.

In the first case mentioned it ultimately transpired that a keeper who had recently been sacked had put down arsenic-treated bait as a measure of revenge on his former employer and, in the second case, the Ministry of Agriculture ultimately established that the hounds had, in fact, been fed with anthrax-infected meat.

More seriously, a few months ago I attended an N.F.U. meeting in London at which all kinds of serious allegations were made against a series of crop protection chemicals by well-intentioned but ill-informed growers. They mixed up statements regarding growth regulator weed-killers and taint of glasshouse tomatoes, schradan and other phosphorus insecticides and the treatment of Brussels sprouts, and DNC weed-killers and the death of game birds. There was sense and nonsense in many of the allegations.

All of which illustrates that it is wise not to be stampeded by alarmist rumours. The truth, which must be disentangled, is usually less serious.

With these general comments I would now like to deal with my subject under the heads of:—

(a) the search for safer products:
(b) the problem of residues in foodstuffs:
(c) the practical handling of dangerous chemicals, and
(d) the current legal position in Britain.

THE SEARCH FOR SAFER PRODUCTS

Partly as a result of the recent deliberations of the various Zuckerman Working Parties, increased emphasis is being placed, as I have already indicated, on the desirability of more research to discover insecticides, fungicides, weed-killers and related products less poisonous to mammals than, for example, the organo-phosphorus insecticides, organo-mercury fungicides and DNC weed-killers.

A tremendous amount of work is going on — in Britain, the U.S., Germany and elsewhere — particularly within the large chemical firms, to uncover new products in this field. But it must be emphasized that until we know a great deal more about the relationship between chemical constitution and insecticidal and other activity on the one hand, and between chemical constitution and mammalian toxicity on the other, it is quite impossible to know how deliberately to look for non-poisonous insecticides, etc. The only practical procedure at present, and the procedure followed by most of the firms mentioned, is to " screen " large numbers of new chemicals for insecticidal, fungicidal and weed-killing activity and, so soon as any looks of interest, to check it for mammalian toxicity.

By way of example, we in I.C.I., the largest interested Company in Britain, opened a new testing station at Hawthorndale in 1935 and in the first ten years " screened " some 14,000 new chemicals or new formulations of chemicals. Less than 0·1% of this number showed promise justifying any further research or development work. Obviously it was very much simpler and cheaper to do the entomological, mycological and botanical testing first and to follow this with the toxicity tests on the relatively few chemicals justifying further work.

Such work as this has produced the relatively safe products—DDT and BHC as insecticides; thiram and the other " educated " sulphurs as fungicides; MCPA, 2,4,-D and 2,4,5-T as selective weed-killers in the past decade or so.

I am often asked, why do firms persist in working among the so-called dangerous chemicals? Taking the phosphorus insecticides as an example, it is true that at present the most valuable insecticides are very dangerous. It is, however, also true that a very large number of phosphorus chemicals are not dangerous, and it has already been established, at Hawthorndale and elsewhere, that the mode of action of at least some phosphorus compounds is quite different in insects from that in the higher animals. Specifically, some have been shown in the laboratory to be highly insecticidal and yet of very low toxicity to mammals. Unfortunately, while these point the way to further research they are not yet practical propositions, except perhaps the new American insecticide, malathion, which is of the same order of activity as parathion but seems to be less toxic to animals even than DDT.

RESIDUES IN FOODSTUFFS

Before I go on to the subject of residues of dangerous agricultural chemicals in food products may I say that I am well aware that the Second Zuckerman Working Party, set up in 1951 by the Minister of Agriculture, is just about due to issue its report on this very subject. As the report has not yet been issued,* any notes I have compiled will be much less complete and authoritative than they might otherwise have been.

* The report has now been issued.

With this proviso, may I indicate how I, personally, approach this problem of the hazards or safety of a new chemical. So soon as we have a new chemical that looks as though it might prove interesting, we carry out animal experiments on a number of different animals to determine its approximate mammalian toxicity. With chemicals designed for foliage application I then proceed somewhat as follows: assume that of the total chemical applied about one tenth stays on the trees and nine tenths falls to the ground. Of the one tenth that goes on the trees, assume that only about one tenth stays on the fruit or edible portion of the crop and, again, if the product has been applied at a reasonable interval before harvest time, probably nine tenths of the residue will have been removed by normal weathering agencies. It is then nearly always found that the resulting figure is well below that which could constitute a real hazard. If, however, it does not, the situation must be looked into very much more closely.

This may sound like an absurd guessing game, but to indicate its essential soundness I can tell you that some years ago, when we had our first complaints of taint of black-currants from the application of BHC, I did exactly this sort of calculation and guessed that the fruit should not contain more than about 2 p.p.m. of BHC. The first results that came from our analytical people said that BHC was present, but certainly not more than 3 or 4 p.p.m. !

To give you another example of the same sort of thing, we sell acaricidal smoke generators based on parathion, and these are designed to distribute 1 gm. of pure parathion per 1,000 cu. ft. of glasshouse. Assuming the volume of glasshouses is of the order of 400,000 cu. ft. per acre, we are distributing approximately 1 lb. of parathion per acre. If the crop is tomatoes and we assume a total crop of, say, 40 tons per acre, of which only 20% is exposed at any one time to a smoke treatment, we can calculate that if all the parathion emitted by the smoke remains undecomposed and goes into the fruit present at the time, then 1 lb. of parathion would be in 8 tons of fruit. This approximates 1 part in 18,000 or 56 p.p.m. In this particular case American data has shown that rats can be fed for two years on a diet containing 100 p.p.m. of parathion. Taking into account, therefore, the fact that only a tiny amount of the actual parathion applied could conceivably remain on or in the tomatoes at harvest, then the procedure is obviously extremely safe.*

Let me make it entirely clear that our final action in introducing new chemicals is not decided by my arithmetic doodlings ! The initial " guesstimates " are followed up by closely controlled experiments involving large numbers of accurate micro-analyses. For example, in the case of parathion smokes as applied to the tomato crop, we have chemical methods of analysis accurate to within 0·5 p.p.m. and which will detect 0·2 to 0·3 p.p.m. These seem to be adequate for most pur-

* The U.S.A. have recently issued a limit for parathion residues on food at 1 p.p.m.

poses, since Lehman in the U.S. does not consider that a parathion content in foodstuffs of between 2 and 5 p.p.m. is likely to constitute a health hazard.* The sort of figures we have found 4 to 6 hours after smoking are 0·0 p.p.m. to 2·6 p.p.m. parathion and the figures fall sharply with time. May I add that we have bioassay methods which will detect far smaller amounts of this chemical.

This leads me to another point concerning analysis. Many people both in this country and elsewhere seem to lay extreme stress on analytical methods for residues of chemicals in food products as the main means of checking hazards. There is no doubt that these methods are most desirable and the results of their use are most informative in many ways. But I must draw attention to the fact that the absence or relative absence of chemicals answering to analytical tests for the chemical applied, does not by any means prove that the produce is safe. Breakdown products of the original chemical which do not respond to the analytical tests for that chemical can and are sometimes left in food products. It is obvious from this that toxicity experiments with animals must continue to be the final criterion.

Still on the question of chemical residues in food products, some very interesting results have recently been reported by Dr. Heller and Mr. Nyquist of the Oklahoma Agricultural and Mechanical College (see *World Crops*, July, 1953, p. 262). They told the American Chemical Society that the washing and cooking of vegetables before eating is very effective in removing possible harmful residues. Parathion and gamma-BHC were used in the work and it was shown that as much as 97% of the insecticide residues was removed by thorough washing and cooking in an open vessel. Washing followed by pressure cooking was, not unnaturally, not so effective; nevertheless they removed 60% to 95% of the residues. Even freezing the vegetables reduced the potential hazard. These workers concluded that: " these data would indicate that under proper conditions of spraying, harvesting and processing such foods there would be a very small probability of the existence of dangerous quantities of spray residues."

The Editor of *World Crops* rightly comments that these findings are of chief significance in connection with vegetables destined for factory processing, since only under factory conditions could one be quite sure of adequate processing to produce the results indicated.

Arising out of this question of mammalian toxicity, I would draw your attention to a few facts that strike me as being completely anomalous and somewhat absurd. From time to time I meet contractors and growers who say they will not touch parathion because it is too dangerous, yet I know that those same men quite cheerfully handle considerable quantities of TEPP and schradan.

What are the facts? I know such figures are difficult to interpret and

* The U.S.A. have recently issued a limit for parathion residues on food at 1 p.p.m.

handle, but summarising results reported by such workers as Dr. Lehman in the U.S. and Drs. Goldblatt and Ripper in this country, we find that, for skin absorption, which is probably the most important factor, pure TEPP is about four times as dangerous and pure schradan slightly more dangerous than pure parathion. Since, however, the normal maximum concentration of parathion in products sold in this country is 20% active ingredient and TEPP is put out as 40%, then during handling of the concentrate the hazard with TEPP is of the order of eight times that with parathion. Of course, once the products have been diluted for some hours with water then TEPP hydrolyses to innocuous chemicals very, very quickly. But, I would repeat, at the time of making up the original sprays for application, certainly TEPP has by far the greater hazard. Similarly, as schradan products are usually sold with 60 or 70% active ingredient, the hazards during initial handling in this case are of the order of 3 or 4 times that of parathion. Furthermore as, in this case, schradan is used at 10 to 100 times the concentration of parathion and is substantially as stable, its hazards are very considerably higher even during application.

May I make it quite clear that I am not attempting to minimise the danger with parathion. It is extremely dangerous and must be handled with every precaution. The point I am trying to make is that practically all the precautions, in a rather more emphatic form, should be exercised with TEPP and schradan.

THE PRACTICAL HANDLING OF DANGEROUS CHEMICALS

I said at the outset that I was not a medical man. Some of you may have read in the June 27th issue of *Chemistry and Industry* this year a report of a paper by Dr. Barnes of the Toxicological Research Unit of the Medical Research Council, under the title "Crop Protection as a Health Hazard." He suggested that the hazards can be considered in relation to the following questions:

1. Are the materials inherently too poisonous for the purposes for which they are used?
2. Are the materials used or applied in the correct or best way?
3. What can be done to meet the existing situation?

Under the first heading Dr. Barnes points out that arsenic alone or in combination with lead has been used in agriculture in enormous quantities. They are both classic poisons feared for their acute and chronic poisonous effects. As chronic poisons they present a residue problem far greater than that of any modern insecticide because they possess no volatility. Similarly, cyanide and nicotine have been used for many years and, although they are highly dangerous, the number of fatalities from their use has been relatively small.

Under the second heading Dr. Barnes points out that the degree of efficiency of application of these chemicals varies considerably and the formulations and packages are not always of the best type. Nevertheless,

improvements are always going on and it is significant that, in the case of parathion in America, the number of fatalities has recently greatly diminished although sales of the chemical have increased enormously.

Under the third heading, Dr. Barnes suggests that one might abandon the use of the toxic materials — but apparently rejects this for the reasons I gave at the outset of this paper. He then suggests the development of compounds which will only poison pests, a matter on which I have already commented. Finally, he deals with improved methods of using existing materials. He points out that supervision in the field is much more difficult than in a factory, but that regulations may be observed if men are employed capable of being properly educated in the safe use of the chemicals.

Without following Dr. Barnes' thesis any further, I would point out that we in the British crop protection industry, as represented by the Association of British Insecticide Manufacturers, codified methods of safe handling of these chemicals and publicised our results among all those concerned, some time before the subject received so much publicity in Parliament, in the Press and elsewhere. We detailed methods of handling dangerous concentrates and diluted washes and dusts, indicated necessary protective clothing and other equipment, showed how to dispose of potentially dangerous empty containers, and the safe intervals between application of such chemicals to food crops and the harvesting of these crops. All this proved a most useful background to the official action regarding the newer chemicals which started in 1950.

THE CURRENT LEGAL POSITION IN BRITAIN

I must now draw attention to the current legal aspects in Britain of this whole problem. As you are well aware, the Poisons Regulations in this country have for many years sought to protect the public from hazards due to the use in industry, agriculture, etc., of dangerous chemicals such as nicotine, lead arsenate and the like. Much more recently, however, some unfortunate accidents with DNC weed-killers in this country and with parathion and other phosphorus insecticides in other countries have led to a close examination of, and a very considerable tightening up of, the position.

You will be aware that in July, 1950, the first Zuckerman Working Party was set up by the Minister of Agriculture and Fisheries with the following terms of reference:—

> " To make recommendations for the promotion of the safety of workers in the agricultural use of substances which are toxic or harmful to human beings; and in particular to advise on the recommendations on this subject made in the Report of the Gowers Committee on Health, Safety and Welfare in Non-Industrial Employment."

This Working Party reported in April, 1951, and, subsequently, an

Enabling Act was passed in March, 1952, which gives the Minister of Agriculture powers to draw up regulations designed to ensure the safe handling of a number of DNC weed-killers and phosphorus insecticides. Earlier this year initial regulations were published in the form of two Statutory Instruments, Nos. 358 and 849. Anyone directly interested in the subject should, of course, read all these documents. In addition, and for those interested in a general way, there are available a layman's interpretation (Form A(PS)1) of the first of the Statutory Instruments and, of course, a very much simplified Ministry leaflet entitled " Take care when you Spray." These give details of the safety precautions now required to be observed by all employers and their employees. I do not propose to detail them here.

The original Zuckerman Working Party was reconstituted in 1951:—

> " To investigate the possible risks from the use in agriculture of toxic substances on the agricultural products and the stored products and, if protective measures appear desirable, to make recommendations as to their form to the Ministers concerned."

This second working party is believed, as already indicated, to be on the point of reporting, but at the time of writing the report has not been issued.*

For the sake of completeness I must point out that the Working Party, still under Professor Zuckerman, has again been reconstituted:—

> " To investigate the possible risks to the natural flora and fauna of the countryside from the use in agriculture of toxic substances, including the possible harmful effects for agriculture and fisheries, and to make recommendations."

Reverting to the requirements of recent legislation, one of the basic difficulties in the use of protective equipment is that, if it is to render the worker entirely safe from all hazards, then it tends to become so clumsy and so oppressive in warm weather that it is extremely difficult to get the worker to wear it, at least once his employer's back is turned. In presenting evidence to the Working Parties, therefore, our own trade association has stressed that a high degree of protection, coupled with equipment designed so that it can be worn over considerable periods in bearable fashion, is eminently more practical and realistic than equipment which is 100% safe but so cumbersome that it will not be tolerated by workmen except under a very considerable degree of compulsion.

In the opinion of those best able to judge, the best safeguard against further unfortunate accidents is the employment of men with a considerable amount of responsibility. This coupled with adequate training will, in the long run, be more effective than any amount of legislation which, at best, is very difficult to supervise.

* The report has now been issued.

From the information I have collected over the past few years, and from the practical experience of my colleagues in this country and overseas, I believe that accidents with these chemicals will be best avoided by employing men with sound common sense and only allowing them to work for limited, intermittent periods.

This second factor is, in my personal opinion, the most important single factor in the whole matter. The human body has very considerable powers of recovery even from such dangerous chemicals as the phosphorus insecticides — so give the body every opportunity. This is probably more important with individual farmers than with contractors — the latter are in a better position, usually, to ensure proper use of adequate protective equipment.

I am confirmed in this opinion by information received from a colleague recently returned from South Africa. Last season, in that country, 1,300,000 citrus trees were sprayed with parathion at high concentration and high gallonages per tree, yet the natives doing the spraying used no protective equipment, in the sense that we understand it, whatever. Some care was taken to see that the labourers did not continue on the job for long periods.

Similarly, another colleague has just returned from Japan, where large quantities of parathion are used by Japanese farmers, again using no protective equipment. Here the work is supervised by Central Government and Prefectural advisers and no one is allowed to apply parathion for more than four hours each on two consecutive days, after which he is kept off the work for ten days.

This aspect of the matter in this country is, of course, covered in Statutory Instrument, 1953, No. 358, page 6, item 10.

I believe it is fair for me to add that by far the greatest number of fatalities resulting from the use of these chemicals has been due either to a lack of appreciation of the dangers or to gross misuse. For example, in the one near-fatality with parathion in this country of which I have the essential details, the operator had worked for 16 hours a day, 7 days a week for 3 weeks and then spilt some of the concentrate on his arm before he was finally knocked out. Fortunately, a colleague of mine was on hand to ensure that that particular man was promptly given heavy doses of the antidote, atropine, and he lives to tell the tale.

Finally, and reverting to my point that lack of precise knowledge can be dangerous, back in 1939-40 my good friend, Mr. F. J. D Thomas, then senior entomologist at the Hawthorndale Laboratories, had two quite serious bouts of what everybody called 'flu, and which no one connected with his current work with DNC. In point of fact, we now know that he was almost certainly suffering from DNC poisoning for, as he himself says, he had every typical symptom except that he did not die !

TREATMENT OF APPLE AND PEAR SCAB IN HOLLAND

by IR. G. S. ROOSJE.

Phytopathologist at the Institute for Phytopathological Research at Wageningen, detached to the Research Station for Fruit-Growing, Wilhelminadorp (Zeeland).

(*Written early in* 1954).

INTRODUCTION.

FROM 1949 to 1952 the average annual production of apples and pears in Holland amounted to 320 million kg. and 131 million kg. respectively. On an average 36% of the apple crop and 31% of the pear crop were exported (1).

In order to continue these exports it will be a prime necessity for Holland to offer large consignments of apples and pears of standard quality.

Among the most serious factors affecting the quality of apples and pears are the fungi, *Venturia inaequalis* (Cke) Wint., and *Venturia pirina* Aderh., the causes of scab.

It has proved quite possible by means of preventive spray applications to avoid scab attacks, but it must be admitted that frequent spraying is not the best solution. Repeated spraying also involves the danger of damage to the fruits by the spray preparations.

As a result of a publication of Sproston (1949) and through the information derived from the scab forecasting card of Mills (1951) more and more attention has in recent years been paid to scab control in Holland by spray applications after infection.

In this article we will give a brief description of preventive scab control as carried out in Holland. After that an account of Dutch experience with post-infection spray applications will be presented. For some years attention has also been paid to the possible influence of scab treatment preparations on the tree. This subject will be discussed briefly in a separate section.

1. PREVENTIVE SPRAY APPLICATIONS.

The spread of scab takes place by means of both the sexually formed

(1) According to the statistics of the Board of Fruit and Vegetables.

ascospores and the asexually formed conidia of the two species of *Venturia* already mentioned. In order to avoid scab outbreaks attention must thus be directed primarily to ascospores and conidia. From the end of March or the beginning of April to about mid-June ascospores may be released from the perithecia formed in the dead leaves of the previous season. In Holland serious attention is nowhere given to rendering the perithecia on the fallen leaves inactive by means of an " eradicant spray " (Keitt, Clayton and Langford, 1941 ; Palmiter, 1946). The results of eradicant sprays of this kind are not considered to be of practical importance for Holland.

The ascospores of *Venturia* are emitted only when the perithecia are moistened. In Holland the Phytopathological Service in conjunction with the Royal Dutch Meteorological Institute (K.N.M.I.) arrange a national warning service. To that end, an investigation is made early in March into the maturing of the perithecia both at points in the middle (Wageningen) and south of the country (Wilhelminadorp in Zeeland) respectively. This investigation is carried out as follows : a number of leaves bearing perithecia are gathered from the orchard and put in a thermostatically controlled container at approx. 26° C. in order to accelerate maturation. When these leaves have been in the thermostatically controlled container for a few days they are artificially moistened, whereby any ascospores released adhere to glass slides located a few mm. above the leaf. If the forcing of the maturation succeeds, and thus the ascospores are emitted as a result of moistening, the conclusion will be drawn that the perithecia outside should be ripe in a few days.

The time at which the perithecia are ripe under natural conditions is more accurately determined by artificially moistening a number of unforced leaves each day in Petri dishes, using for preference different varieties and sources. Object glasses are again placed a few mm. above the leaves in these Petri dishes so as to determine whether or not there has been an emission of ascospores after some time.

If the buds of the trees have developed to such a degree that infection by scab spores could occur, a caution is broadcast, at an hour of the day known to growers, that in the event of rainfall there is a chance of infection. This warning of the first emission of ascospores in a season is the most important but warnings are also given of subsequent emissions. In the case of subsequent emissions, attention is directed principally to the rainfall to be expected so that growers who have sprayed a long time previously are reminded of the desirability of another spray application.

In Holland ascospores form the principal source of infection. On most of the varieties of apple and pear grown here there is no branch scab. Branch scab can sometimes be found, however, on the apple varieties Pfirsichroter Sommerapfel and Cox's Orange Pippin, and on the pear varieties Clapp's Favourite and Beurre Hardy, but more frequently on the pear varieties Précoce de Trévoux and Bonne Louise d'Avranches. The stromata, principally those on one-year-old

shoots, may, in the event of rainfall, release conidia very early in the spring. Where branch scab is present, therefore, the conidia form at least as important a source of infection as ascospores. The radio warnings must, of course, take both these sources of infection into account.

Apart from the national warning service, there are also regional warnings in Holland. These regional warnings are arranged by sections of the Dutch Fruit-growers Organisation (N.F.O.). They normally use postcards for their information.

Generally it can be said that the warnings regarding scab are very satisfactory as far as the first spray application of the season is concerned; for the other spray dates the warnings often involve difficulties.

The avoidance of scab by preventive spray applications *means in practice* that the grower must see that the trees are constantly covered with an active layer of the protective fungicide. This involves a large number of applications because most of the anti-scab preparations so far used possess only a limited period of protection. The period of protection of a fungicide is determined by the period during which the fungicide is active and its re-distribution over the surface of the leaf and fruit on renewed moistening of leaf and fruit.

The fruit-grower is naturally specially interested in the period of protection. He would like to hear from the extension service that preparation A has a period of protection of so many days and preparation B of so many days. This is, however, impossible because the period of protection of a fungicide depends not only on the period of action and concentration, but also on the weather conditions and on the growth of shoot, leaf and fruit.

In fact, as far as the length of the period of protection is concerned, we can give only a very rough indication of efficacy of the anti-scab preparations which are used in Holland.

The preparations containing copper, of which copper oxychloride 50% is principally used against scab, appear to afford the longest protection. The copper preparations are followed by captan (N-trichloro-methyl-thiotetra-hydrophthalamide) which was, however, much too expensive in 1953 in comparison with other fungicides. After this comes a large group of chemicals, which can give an approximately uniform measure of protection. In this group we can include : lime sulphur, wettable sulphur, dimethyl-dithiocarbamates, preparations containing dinitro-benzene thiocyanate, and tetramethyl-thiuramdisulphide. Such circumstances as the prevailing temperature and rainfall will on one occasion be to the advantage of one preparation of this group and other conditions to the advantage of other substances.

The organo-mercury compounds which are used in Holland against scab usually show the shortest protective period in practice. These organo-mercury compounds are not of the same composition as the

mercury compounds used in America, such as Puratized, Tag 331 and others. The composition of the Dutch preparations is kept secret.

II. POST-INFECTION SPRAY APPLICATIONS.

In order to discuss the treatment of scab after infection it is desirable to make a distinction between treatment during the incubation period and treatment of already visible scab. Spray application at the beginning of the incubation period is described below as a curative spray. The incubation period begins at the time when the hypha of the germinating spore has developed to such a stage that it has become independent of the food supply from the spore.

II. (1). Curative spray applications.

Keitt and Jones (1926) have already pointed out that the minimum period during which apple leaves must be kept moist for producing an infection by ascospores of *Venturia inaequalis* depends on the temperature during the period of moistening. Mills (1951) has drawn up a scab forecasting card from observations extending over fourteen years. From this it is possible to determine for each combination of (a) period during which the leaves are wet and (b) average temperature during this period, whether the weather conditions have been favourable for light, moderate or severe infection. Since 1952 the data on Mills' card have been tested in Holland. In various parts of the country trials have been carried out in which the results of preventive spray applications have been compared with those of curative spray applications (Committee for the Control of Scab, 1953). The dates for the preventive spray applications were determined as a result of practical experience ; but the data on Mills' card were used to decide on the dates for the curative spray applications. A number of trees were also left untreated in the trials. In this way we could determine whether certain combinations of moist conditions and average temperature over this period led to infection.

Under the weather conditions which occurred in the past few years the data of Mills' card appear to be on the cautious side for Holland also. If the details are not too much on the cautious side the method of curative spray applications has the big advantage that one does not spray too often. In fact, it has appeared from the tests made in Holland up to the present that the use of curative sprays with organic mercury preparations involves a smaller number of spray applications than those required by the preventive method to achieve equally good results. The possible saving will usually not be more than two spray applications per season.

Against the advantage of the curative spray method indicated here there are a number of drawbacks with respect to the practical application of the method in Holland. These drawbacks will be discussed below point by point.

1. Fixing the period of infection.

The determination of the period of infection (duration of moist conditions and average temperature during this period) cannot be dealt with centrally or regionally because considerable local differences in the length of the period are possible.

During the day the beginning and end of moist conditions can be ascertained. At night the beginning can be established with the aid of a precipitation gauge if observations by persons on night duty are not possible. The best device will be a self-recording rain-meter. Of importance is the construction of an apparatus which could be paid for by each grower. Various Dutch institutions are working on the development of a good, cheap rain-gauge.

There are as yet no means of determining the end of the period of moist conditions at night, although it is a fact that the trees usually remain wet the whole night when they are sufficiently wet late in the evening.

The average temperature during the wet period of the tree can easily be ascertained with the aid of a thermograph. In this case also it is evident that a cheaper method should be found. The Royal Dutch Meteorological Institute (K.N.M.I.) at De Bilt is at present investigating whether it is, in practice, sufficient to use the temperatures recorded on the existing synoptical stations of the K.N.M.I.

The difficulties in the determination of the period of moist conditions and average temperature apply only when it is doubtful whether there is a period of infection. It is only then that accuracy is important. So long as accurate determination of the period of moist conditions and the average temperature on a fruit farm is not easy the grower must allow for an ample margin of safety, which means that in doubtful cases he must spray.

2. Limited choice of products to be used.

Only organic mercury preparations have shown satisfactory curative action in trials as well as in practice when applied to the tree within 96 hours after the beginning of a period of infection. None of the other scab treatment preparations used in Holland can be considered for large scale practical curative application.

Organic mercury preparations cannot be used in all cases without injury. During and after blossom, mercury is not advisable on all varieties of pears or on the apple varieties Cox's Orange Pippin, Transparente de Croncels and Groninger Kroon, in view of the possibility of injury. In this connection it should moreover be pointed out that the risk of damage from mercurials appears to be greater, even on varieties which are moderately sensitive to mercury, when these sprays follow those with a fungicide of milder effect, as for instance tetramethylthiuram disulphide.

Apple affected with scab (*Venturia inaequalis*)
No spray treatment

Healthy apple—
protected by spraying with captan

Apple storage scab (*Venturia inaequalis*)

Apple scab lesion on shoot

Apple scab (*Venturia inaequalis*) *on leaf*

In cases where organic mercury compounds are too risky, we might consider profiting from the curative action of captan. The curative action of captan is in practice only important when the spray can be applied within 24 to 36 hours after the beginning of a period of infection. As has already been pointed out, the high price of captan restricts for the present the use of this fungicide.

The main period for scab treatment extends from the end of March to mid-June. After mid-June products other than organic mercury are to be preferred. A careful toxicological investigation is being made by the Institute for Public Health in order to determine to what extent difficulties are involved in the use of mercury compounds in the period up to mid-June.

3. Spray applications during rain.

It is possible that the weather conditions for a number of days after the beginning of a period of infection may be such that it is preferable not to spray. In Holland there is a general disinclination to carry out spray applications during rainfall and when the trees are continuously wet, because under these circumstances unsatisfactory results are expected. In the U.S.A., however, spray applications are often made during rain. It is certainly necessary to do this when caught by rainfall and when fungicides with a preventive action only are being used. With fungicides of primarily preventive action one must always spray before the hypha of the germinating spore has become independent of the supply of foodstuff from the spore (see also page 131 under II). The chance that one shall have to spray *curatively* while the tree is still wet, is, at least under Dutch conditions, even when organic mercury compounds are used, relatively great. Growers should bear in mind that it is better to spray early on wet trees than too late on dry trees.

4. Wet soil.

After heavy rainfall the soil may be so saturated that the tractor cannot move the spraying machine. In case of clay or silt loam soils, where there is no grass, the method of curative spray applications would appear to have little practical importance for these reasons.

The difficulties mentioned provide the reason why it is impossible to recommend general application of the curative spray method. In principle we should keep to preventive spray applications. If, however, the grower cannot cover the trees early, i.e. before an infection, with a protective chemical, he can in many cases eliminate scab after infection by curative spray treatment with a suitable organic mercury compound. For this each fruit-grower must learn for himself to determine when infection does occur.

II. (2). Treatment of visible scab.

As long as even the best fruit-grower can be faced with a fairly serious attack of scab, the treatment of visible scab demands a solution.

The difficulties connected with therapy of plant diseases in general are encountered here, also, to the full. So far little investigation has been made into the therapy of scab, as it is meant here.

The serious fruit-grower has tried more than once to kill the already visible leaf scab with organic mercury compounds. Complete success is often not achieved but it seems that under specific, but as yet unknown conditions, it is possible to reduce appreciably the leaf scab attack. Organic mercury compounds afford the best chance of success, but a reduction of leaf scab is sometimes effected with other scab treatment preparations. It seems to us that a factor can be found in the condition of the trees which can contribute to determining the success of this therapy. We are supported in this opinion by the observations that *Venturia* sometimes loses vitality on unsprayed trees.

III. INFLUENCE OF SCAB TREATMENT PREPARATIONS ON THE TREE.

It is known, both in the case of the conventional scab treatment preparations as well as with the organic preparations of a later date, that clearly-visible leaf and fruit injuries can occur.

In general these injuries can be more easily avoided by using the new organic compounds rather than the classic copper and sulphur fungicides.

It has been proved that fungicides can have an effect on certain physiological processes of the tree in the absence of visible injuries. Thus, for example, lime sulphur can produce an appreciable reduction of photosynthesis in the first days after spraying (Hyre, 1939).

The fact that leaves are able to absorb certain elements from the substances used as sprays can be illustrated from the success achieved from spray applications with manganese sulphate and magnesium sulphate against manganese and magnesium deficiency respectively. It must also be assumed that scab treatment preparations influence the mineral composition of the leaf. Proceeding further on this assumption, an attempt has been made by means of leaf analyses to discover what changes are caused in the mineral composition of the leaf by the fungicides mentioned. The results of leaf analyses should, however, be interpreted with great caution, in view of the fact that climatic conditions also cause changes in the state of nourishment of the tree. These conditions may vary with the season, which may result in the fact that the influences of the spray preparation also vary likewise. It is thus difficult to draw conclusions which would have general application.

The fruit-growers do not place much importance on the possible harmful results of the use of spray preparations as long as they are not visible. They tend in recent years to make more and more use of the new organic preparations in order to limit visible injuries.

However, it is to be expected that in the future the use of dispersible

sulphur will again become more popular, since the spread of apple mildew (*Podosphaera leucotricha* (Ell. and Ev.) Salm.) is checked by sulphur but not by the new organic preparations. Apple mildew has been increasing constantly in recent years in Holland. The increase in the use of organic preparations in the treatment of scab is often held responsible for the more severe occurrence of apple mildew. The importance of apple mildew has also increased due to the popularity of the apple variety Jonathan, which is very susceptible to mildew.

SUMMARY.

After a few years' trials it seems that apple scab (*Venturia inaequalis* (Cke) Wint.) can be very effectively treated by curative spray applications with organic mercury preparations providing they are applied within 96 hours after the beginning of a period of infection. The periods of infection were determined according to the data on Mills' scab forecasting card.

Various difficulties, in particular those found in establishing the periods of infection, are the reasons why curative spray applications cannot in general be advised. Fruit-growers should, therefore, chiefly make preventive spray applications. If, however, a preventive spray application cannot be made early, a curative spray application will eliminate the attack. Treatment of visible scab affords little chance of success.

A tendency of recent years is the gradual replacement of the classic copper and sulphur compounds by dimethyl-dithiocarbamates, organic mercury compounds, dinitro-benzene thiocyanate and tetramethyl-thiuram disulphide. Possibly, as a result of these developments, there has been an increase in the incidence of apple mildew (*Podosphaera leucotricha* (Ell. and Ev.) Salm.).

Only sulphur sprays can be considered for the joint treatment of scab and apple mildew.

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ORGANIC FUNGICIDES

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SUMMARY.

THE search for chemicals to replace copper as a fungicide in agriculture, and particularly viticulture, has for a long time received the closest attention of research workers.

The problem is of considerable economic importance, especially in view of the fact that in the long period of time during which vines have been treated with copper washes in Europe and North Africa more than two million tons of metallic copper have been used.

Recently, research has been directed towards the organic compounds, and several of these, of synthetic origin, have been tested. Some of them have proved useful for special problems.

The great amount of work done in this field, as well as that now planned and in progress, stresses the immense importance of this line of research, as well as the difficulties to be overcome.

This paper attempts to give an up-to-date review of the problem.

THE countries which are important consumers of fungicides are generally not producers of copper. The replacement of this metal by an organic compound, for instance, as a fungicide base would, therefore, be of very great economic importance.

In the vine-growing countries of Europe and North Africa alone the pre-war annual consumption of copper sulphate has been estimated at 250,000 tons, equivalent to more than 60,000 tons of metallic copper. During the long period in which vines have been treated with copper washes and powders it is probable that more than two million tons of metallic copper have been used in viticulture — two million tons which are irrecoverable.

One can, therefore, easily appreciate the great economic importance of the replacement of copper salts by other products and the attention

which is being given to the problem by a large number of specialists, especially during the last few years. The search for non-copper fungicides effective against *Plasmopara viticola* was started more than fifty years ago, but was confined almost entirely to the field of inorganic chemistry. The search was apparently thorough and systematic but produced only disappointing results. No other metal could be substituted for copper.

The synthetic organic compounds remained to be examined. This immense field had already produced some excellent compounds with high insecticidal value and its exploration with a view to discovering fungicides of good quality was naturally tempting.

In this paper no reference will be made to work which produced no results of any real importance, carried out in this field before the last war. But it must be recalled that during the period, 1941 to 1944, a large number of organic products were tested. It appears that the only one which showed any value in viticulture was a product of mixed formulation, 23·17W based on sulfocyano-dinitrobenzene, containing a certain amount of copper (2·3% in a sample analysed by Solvay Laboratories), most probably in organic combination. No reference would have been made to this product if the interest which was aroused in it had not been resuscitated — though in a somewhat different manner — very recently. Mention must also be made of the English compound ' Shirlan ', based on salicylanilide, the fungicidal properties of which have received and are still receiving attention in industry (textiles) and agriculture.

This organic fungicide has stood the test of time and is still being used on various crops. Before the war, salts of orthoquinoleine (specially sulphates) were also tested, and certain results on fruit trees were obtained. Then, a great many investigators directed their efforts towards the fungicidal action of certain colouring matters. Mr. R. Marcard (1) noticed in 1931 that Acridine E orange and bright phosphine S had a preventive action against the vine mildew. The mechanism of this action has so far — to our knowledge — remained unexplained.

But it is specially since the last war that work on organic fungicides has been carried out, stimulated by the search for a product — or products — *without copper*. The economic conditions of the last few years, the scarcity of the valuable metal with preventive properties, and the cost and the difficulties of its supply, then and now, explain the fervour with which studies have been pursued in the main vine-growing countries. The interest in the problem was just as keen in the non-vine-growing countries for obvious reasons.

Just as in the field of human and animal therapeutics, there have been great advances in vegetable therapeutics. As already mentioned organic insecticides have been established on the market, have largely supplanted the mineral-based insecticides and have increased the range

of application of these products. Several hundreds of organic products have also been tested as fungicides in agriculture. It will not be possible to review them all; many of them have been rejected after laboratory tests only. Others have been discarded or altered after field trials. The author knows a specialist who has compared the standard copper washes with about 300 products without copper. He stresses, however, that tests on only 300 products are insufficient. Instead of 300 products, 20,000 should be tested (2). This explains why consideration is being given in this paper to a few products only; those which have so far given promising results.

At the end of the last war, the attention of the specialists was particularly directed to two new organic fungicides, which were submitted to a great number of trials in several countries, and which are described in the following paragraphs.

ZINC ETHYLENE BIS-DITHIOCARBAMATE.

This active product had already been examined in Switzerland in 1942. Known under the name Dithane, the preparation was tested in Switzerland, France, Algeria and Morocco. More recently, Dithane was tested in Great Britain, particularly on fruit trees. Other carbamates have not given equivalent results in viticulture.

Reports of trials carried out on this fungicide have included the following comment :—

" These results (1952) may be considered as confirmation of the trials carried out in 1951, which showed that effective protection is given by several applications of zinc ethylene bis-dithiocarbamate at 0·3% strength " (3). Similar observations were made on vines in Champagne in 1951 (4). Here also the interesting efficacy of the product was noted. In the Mediterranean area the following observations were made :—

The rate of 300 grm. of zinc ethylene bis-dithiocarbamate did not give better results than 2% Bordeaux Mixture. It must, however, be pointed out that the rate of 900 grm. gave better results (percentage of grapes attacked by mildew and final weight of the crops) than the rate of 300 grm., but still did not give better results than 2% Bordeaux mixture (5). In the opinion of the author the best report on the trials carried out so far on the subject is that of Mr. J. Branas (General Report on Mildew, VIIth Congress of the Vine, held in Rome in September, 1953).

His conclusions were that under the conditions of the most precise tests made, Dithane applied at the economic rate recommended by the manufacturer does not give as good protection as Bordeaux mixture at 2%. It remains to be determined whether a higher concentration would make it possible to reach the result achieved with Bordeaux mixture, and what this concentration is. Protection, however, is an undeniable fact. (6).

It will be remembered — and all research workers have mentioned it — that in the last few years attacks of *Plasmopara viticola* have been generally less serious. In certain areas and in certain years, mildew has been practically non-existent. Interesting results have, however, been noted ; useful information has been obtained from the trials carried out, but it is too early to draw definite conclusions. Further trials are indispensable and we must hope, from the experimental point of view, that the disease incidence of the current and subsequent years will be such that definite conclusions may be reached. It will be realised that to attain this result may take some time.

N-TRICHLOROMETHYLTHIOTETRA-HYDROPHTHALIMIDE.

or N-Trichloromethylmercapto 4-cyclohexane 1, 2 dicarboximide.

This product is prepared by the action of perchloromethylmercaptan on the sodium salt of tetrahydrophthalimide.

The synthesis of the organic complex, which contains, among other products, 42·2% of total chloride, was obtained by the Standard Oil Cy. (U.S.A.) about 1944 ; it is the 406th of a series of some 600 products which have been studied by Standard during the last few years (7). The product is prepared from certain petroleum derivatives.

The commercial product was first introduced under the name T.P.13, later Orthocide. Since 1953 it was more generally called captan. It contains 50% of active material, S.R. 406. Since the end of the war, captan has been tested in various countries. There are reports of trials carried out on vines in France, in the Grand Duchy of Luxembourg, in Switzerland, in North Africa and more recently in Great Britain on fruit trees. The various continental workers have noted the efficacy of the product and their comments are summed up as follows :—" No doubts remain as to the possibility of successfully treating downy mildew (*Plasmopara viticola*) with non-cupric products."

The investigators of S.R. 406 have made comparative trials with Dithane, nearly always using Bordeaux mixture at 2% copper sulphate as the standard.

In this article the results of the more important experiments only will be reported. The fact that S.R. 406 is an effective fungicide is unanimously admitted. Even if the action of the product at a low concentration is less than may be desired, it is nevertheless certain. Some investigators, on the basis of one year's results, do not hesitate to attribute an equal value to the sprays containing 500 gr. or even 250 gr. of S.R. 406, and to Bordeaux mixture at 2% (5). These investigations will not be discussed in this paper but attention is drawn to the opinion of the workers at the Station de Phytopathologie Vegetale, Gironde (France), who find that S.R. 406 can be as effective as Bordeaux mixture (3). These workers, however, naturally stress the point that the experimental results are applicable only to the conditions prevailing during

the years of their trials. Caution is needed in drawing definite conclusions from such investigations.

The results of trials with S.R. 406 which the writer had the opportunity of observing in Italy in 1953 will be discussed at greater length. It is well known that in Italy Bordeaux mixture is usually applied at a strength of 1%. Comparative treatments were made with washes containing 0.3% of S.R. 406 for the first two applications and 0.5% for those following, in a seven years old vineyard planted with the variety Merlot, in the damp plains of the Padua area. Ten applications were made between 11th May and 15th July, 1953. From April to July there was frequent rain (358 mm. = 14" in 49 days) with a minimum temperature of 10° C. (50° F.).

On 7th August a count was made of the grapes attacked by mildew, with the following results :—

Bordeaux mixture	89%
S.R. 406	2%
No treatment—control	100%

As regards the protection of the grapes it can be seen that in the above mentioned trials S.R. 406 at concentrations of 0.3% and 0.5% has proved to be appreciably superior to Bordeaux mixture at a concentration of 1% and that the action of the organic fungicide has been remarkable.

In other trials, however, especially in France, it has often been noted that S.R. 406 lacks persistence. Many investigators have observed that the persistence of S.R. 406 is influenced by climatic conditions, being especially reduced by long exposure to sunshine, which seems to affect the fungicidal properties of the product. This is not surprising as it is well known that a great many organic materials are liable to decomposition by heat and light. A stabilizer would probably prevent this, and work is believed to be in progress on this problem. This also holds true for Dithane.

In the case of the Italian trials, the low number of hours of sunshine during the summer of 1953 in the area of Padua can explain the persistence noticed on the grapes.

On the other hand, the plots treated with S.R. 406 were characterized at the beginning of September by a premature leaf fall following an attack of ' Mosaic ' mildew (form of downy mildew). This occurred before that on the plots treated with Bordeaux mixture. This observation was made by other investigators in France (8) and in Switzerland (9).

Dr. Miotto, of the Padua Faculty, who studied the trials closely, thinks that copper, independently of its fungicidal action, has a physiological action on the leaves, making them more resistant to late infections. The opinion of Prof. Gola of the same Faculty is that treatments by means of copper salts would strengthen the osmotic gradient

in the cells of the leaf parenchyma, which would provoke an increase in absorption and circulation of the water in the plant. These explanations seem to be worth noting.

Whatever may be the cause the vines treated with organic fungicides —and this has been observed by various investigators—appear to be more susceptible to late attacks of oidium.

In Champagne, Mm. Maury and Moreau found widespread attacks of oidium on vines treated with Dithane (4). In Gironde, on an estate of Pauillac, the writer noticed the same phenomenon in 1953 on vines treated with S.R. 406, at least on certain plants. In the Italian trials, the same observations were made, namely, late and characteristic attacks of oidium occurred affecting the leaves only, hastening their fall.

It would be premature to write of a particular and specific action of the organic fungicide which would be favourable to the development of oidium, as presumed by a specialist in vegetable pathology. The physiological action of copper on plants was pointed out more than 50 years ago and it seems that we can still accept the following opinion : that the use of copper salts results in an alteration in the rhythm of vegetation which extends the duration of the vegetative period.

Dithane and S.R. 406 have sometimes also produced phytotoxicity on the foliage. One of the two fungicides (S.R. 406), the composition of which has been altered, did not, to the knowledge of the writer, cause phytotoxicity in the 1953 trials.

OTHER ORGANIC FUNGICIDES.

The discussion of this subject will be limited in this paper to the fungicides applied to the growing plant. Some organo-mercuric compounds have been tested ; certain synthetic fungicides have been found useful on fruit trees particularly, such as alphachlorobetanaphthol, orthophenylphenol, certain derivatives of the thiuram sulphides, the xanthates, the derivatives of glyoxalidine, 2-4 chloro 1-4 naphthoquinone and pentachloronitrobenzene, used on vegetables, to mention only the most important of these products.

SYSTEMIC FUNGICIDES.

The immunization of the plant against the pest or disease, whatever it may be, would be the ideal solution. Such researches are not considered utopian. There are already, in the insecticide field, systemics which have been widely used, and as a result of which the self-defence of the plant against certain insects has been thoroughly secured.

The systemic fungicides have been and are still the object of intensive research in Great Britain ; research dealing, according to certain publications, with the 2-3-4-5-6 pentachlorophenoxyacetic, 1 chloro-2 naphthoxyacetic, 2-4-6 trichlorophenoxyacetic acids. Work on these lines has been just as active in the U.S.A.

The field of antibiotics is also being carefully investigated by great research laboratories, among them that of I.C.I. in Great Britain, where the use of antibiotics as systemic fungicides (Viridin, Griseofulvin) is being studied.

The question is being actively followed up in the U.S.A. In France, interesting trials have been conducted, with promising results, on antibiotic substances extracted from other fungi.

CONCLUSIONS.

This paper has given only a general survey of the organic fungicide problem and it has been an attempt to describe the present position. We realize that it is incomplete but our excuse is that the field is wide, that the results so far obtained have only a passing value, that new products are always appearing, and that tests are long and often disappointing because all the conditions are not fulfilled which would make it possible to draw more definite conclusions.

It must, however, be admitted that in a few years great progress has been made. For the first time, organic fungicides have been shown to have promise when compared to copper preparations, and have sometimes given unexpected results.

The chemical treatment of the downy mildew of the vine especially, which costs many hundred millions of pounds every year, has unquestionably reached a new stage. The final result may be far off, but recent advances in organic chemistry—though often wrapped in mystery—give us great hope for the future.

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THE TREATMENT OF MEALY BUGS ON VINES IN EGYPT

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DURING the summer of 1953 mealy bug attack on vines was so heavy in Coastal Regions of Egypt that vine growers became exceedingly concerned. The aim of this article is to give a description of the life history of the insect on the vine and to inform the reader of the economic results achieved by successful measures of suppression.

INTRODUCTION.

Egypt is probably the only country in the Mediterranean area that is not troubled at present by the *Phylloxera*, Order *ORTHOPTERA*, Family *PHYLLOXERIDAE*, which I attribute chiefly to the fact that American stock, or grafted varieties on American stock have never been imported into Egypt. Another factor contributing to its non-existence in Egypt might be the very heavy summer irrigations carried out in this country, as a result of which the insect would probably be killed.

The country is, however, afflicted with another and similar insect, the *Pseudococcus citri* (Risso), Order *HOMOPTERA*, Family *COCCIDAE* —which, besides being found mainly on vines, lives on many fruit and ornamental trees. It causes severe damage in Egypt and has obliged many growers near Kafr El Dawar to abandon vine growing.

MODE OF ATTACK AND LIFE HISTORY.

Young vines are not attacked. The insect prefers older plants because it attacks chiefly the fruit bunches and these do not appear before the vines are mature.

A description of the life cycle of the insect as it occurs in Egypt is worth mentioning.

During the winter the adult females hibernate under the loose bark of the vine stem, chiefly on the crown of the roots. The adult mealy bugs deposit their eggs, between 300 and 600 in number, in a compact, cottony waxy sac beneath the posterior of the body. Egg-laying continues for 1 or 2 weeks and as soon as it is completed the female insect dies.

The young mealy bugs remain in the egg case up to April or even May and then crawl over the aerial part of the vine. They are flattened,

oval, light yellow, six-legged bugs, with smooth bodies. They feed by inserting their slender mouth parts into the plant tissues and sucking the sap. Shortly after they begin feeding, a white waxy material begins exuding from their bodies and forms a covering over the insect.

If the young nymphs are not attacked at this stage, they feed first on the green tender shoots, waiting for the sugary juice of the grapes, on which they become established and start feeding by piercing the berries with their proboscis. Grape juice, which is sweet by that time, is then exuding out of the berries ; the insect itself produces a sweet excretion. As a result of this we get a secondary attack of the saprophytic fungus *Capnodium* (*Fumasine*) formed on the wet bunches, totally spoiling the quality of the fruit through their sooty appearance.

The grape juice gets on the branches and stems, upon which the *Capnodium* saprophytic fungus then grows and totally blackens them.

By this time (October) a second generation of the mealy bug has probably appeared and the females have started retreating to their winter refuge under the bark at the crown.

TREATMENT

The writer considers that the eradication of the mealy bug, once it is established in the vineyard, is a very important problem. The grapes are not only rendered unsaleable, but the plants are weakened to such a degree that they are rendered un-productive and finally killed.

Many measures have been tried up to the present but without success. Those that have checked the spread of the pest economically are the following :—

1. During winter, soon after pruning, scrape off the loose bark from the crown to the branching of the vine to expose the hibernating insects. Carefully collect all scrapings and burn them immediately.
2. Spray with a good winter wash, like ' Ovicide ' of Plant Protection Ltd., at 5 to 7%.
3. If the attack is very heavy and the insect is established on the crown, apply 20 grms. of ' Paradex ' (Paradichlorbenzene) of I.C.I. to each plant just before the spring irrigations. ' Paradex ' is a volatile substance, which will descend into the soil with the irrigation water and then the gas given off will kill all bugs on the crown and the roots which have escaped from the ' Ovicide.'
4. Burn all prunings to destroy any mealy bugs that are on them.
5. During the summer, when the young nymphs of mealy bug start crawling towards the aerial part of the plant (in Egypt, April and May), spray with 1 : 2000 ' Fosferno ' 25 of Plant Protection Ltd., which up to the present has given the best results as a summer spray. Spray once more in case some insects have escaped and found their way to the bunches.
6. If the measures suggested are carried out thoroughly for one year, and if, during that year DDT is avoided (DDT kills the parasites and predators of the mealy bug but does not kill the latter), mealy bugs will not be totally eradicated but checked for some years.

TECHNICAL BREVITIES

This section includes information on plant protection problems obtained from published literature.

INSECTICIDES

LOCUST ERADICATION

According to C. du Plessis, in *Farming in South Africa*, Vol. 29, No. 334, pages 48 to 49 and page 57, 1954, trials with locust contact poisons in South Africa have shown none superior to BHC. Parathion and malathion were as good as BHC, but precluded because of their mammalian toxicity. Aldrin was slower in action, and endrin and isodrin were inferior. BHC sprayed or dusted from aircraft at normal to heavy dosages was shown to be harmless to grazing sheep. In aircraft trials BHC dusts were unsatisfactory because of agglomeration, but 100% kills of adults were given with 4% gamma-BHC in oil sprayed at 1 gal. per ac. (11.23 *litres per hectare*).

TREATMENT OF FIELD CROPS AGAINST CUTWORM

In the *Queensland Journal of Agricultural Science*, Vol. 11, No. 1, 1954, pp. 1 to 14, A. W. S. May and T. Passlow state that the application of DDT 25% pp'. isomer at ½ lb. per acre (0.6 *kg. per hectare*) was the best treatment against the cutworm, *Agrotis infusa*, out of seven insecticides used in plot trials. Lucerne yield was increased from 2.95 to 3.17 tons per acre (7401 *to* 7952.9 *kg. per hectare*). DDT at ½ lb. per acre (0.6 *kg. per hectare*) was also effective against an armyworm (*Leucania unipunctata*); satisfactory kill was not attained before 4 days.

SEED TREATMENT AGAINST FLEA BEETLE: CHEMOTHERAPY BY BHC

In the C.R. Acad. Agric. Fr., Volume 40, No. 13, 1954, pages 491 to 493, L. Bonnemaison and P. Jourdheuil report results of experiments in France against flea beetles (*Phyllotreta* spp. and *Psylliodes chrysocephala*) by wet and dry treatments of rape seed with insecticides at high concentrations. Laboratory tests showed that the dips—6 hours in 2% concentrations of lindane emulsion 12%, BHC suspension 12% gamma isomer, methyl parathion emulsion 20% and ethyl parathion suspension 5%—were all highly phytotoxic. Of the dry treatments, lindane 20% and 65%, each at 10 grm. per kg. (1½ *oz. per* 10 *lb.*) gave

good results. Persistency tests to cover the period of maturation and flight, in which the tops of seed-treated plants were fed to adult insects, showed that BHC acted systemically: against *Phyllotreta* spp., the BHC suspension 12% gave 100% kill for 17 days and 35% kill on the 22nd day; lindane emulsion 12% gave percentage kills of 100, 95, 60 and 5 on days 8, 13, 17, and 22 respectively; corresponding percentage kills for lindane 65% dust were 100, 35, 10, 10 and for lindane 20% dust, 95, 10, 0, 0. *Psylliodes* was more resistant. In the field, seed treatment of winter rape in August with a 65% lindane dust gave an increase in stand over the control of 28% when applied at 5 to 6 grm. per kg. ($\frac{4}{5}$ *to* 1 *oz. per* 10 *lb.*) and an 83% increase applied at 10 to 12 grm. per kg. ($1\frac{1}{2}$ *to* 2 *oz. per* 10 *lb.*). It is concluded that seed treatment should give satisfactory protection against *Phyllotreta* spp. if attack is not too severe and rainfall is normal, otherwise supplementary dusting or spraying is necessary. Seed treatment should also be satisfactory against *Psylliodes* but if the autumn is mild, so that the feeding period is prolonged, the plants should be treated at the 2-leaf stage.

TREATMENT AGAINST CLOVER SPITTLEBUG: TOXICITY OF BHC VAPOUR

In *Agricultural Chemicals*, Vol. 9, No. 7, 1954, p. 63, it is recorded that the vapour toxicity of BHC renders it superior to toxaphene in the aerial treatment against spittlebugs (*Philaenus* spp.) on red clover in Ohio. Lack of penetration of the foliage cover, even of those plants only 8 in. (20 *cm.*) high, was responsible for this failure of toxaphene as it did not exhibit the vapour action as that possessed by BHC. Trials indicate that as little as 10 lb. per acre (11.2 *kg. per hectare*) of granular type of certain insecticides show promise. Tests are to be made at Ohio Agricultural Experimental Station, according to C. P. Weaver.

SUGARCANE WEEVIL ROOT-BORER AND WHITE GRUBS

In the J. Agric. University of Puerto Rico, Vol. 38, No. 2, 1954, pp. 108 to 114, it is reported that in tests in Puerto Rico with newly hatched grubs of the weevil root-borer of sugarcane, *Diaprepes abbreviatus*, as indicators of the residual effects of insecticides mixed with soil, gamma BHC gave no kill, though it was fully effective against white grubs of *Phyllophaga portoricensis* 3 years after application. Chlordane and aldrin were fully effective against weevil grubs for 3 years, but lost much of their toxicity to white grubs. DDT retained its toxicity to both weevil and white grubs for 3 years.

COTTON PEST TREATMENT: SPRAYING ECONOMY

In the Report of the *East African Agricultural and Forestry Research Organization* for 1953, published in 1954, pp. 30 to 32, K. S. McKinlay states that in a long cotton-growing season in Uganda, with insect

attack of medium intensity, loss of fruiting points by insect damage does not inevitably lead to reduced yields. The plant compensates early losses with points formed near the top of the plant, and if these are protected by late-season sprays the yield is greater than that from plants protected from early attack. Early spraying gives an earlier but not a larger crop. Contrary to normal expectations spraying throughout the season gives no increase in yield over the controls. Protection can, therefore, be limited to a period of one month only, and the reduction in spraying makes the use of insecticides profitable.

MAIZE BACTERIAL WILT

G. H. Boewe states in *Plant Disease Reporter*, Vol. 38, No. 6, 1954, p. 388, that in Illinois bacterial wilt or Stewart's disease of maize is caused by *Bacterium stewartii*, which overwinters in the bodies of adult corn flea beetles (*Chactocnema pulicaria*). DDT at 1½ lb. per acre (1.8 *kg. per hectare*), applied 5 to 7 times at weekly intervals after the first appearance of *C. pulicaria*, is tentatively suggested as a treatment against the disease, especially on early plantings.

APPLE SAWFLY

In the *Report of the Agricultural and Horticultural Research Station, Bristol*, for 1953, published in 1954, pp. 135 to 138, S. H. Bennett states that field trials with BHC wettable powder (0.007% gamma isomer) against apple sawfly, *Hoplocampa testudinea*, showed that the insect could be successfully combated without complete coverage of fruitlets if it is applied before egg-hatch. When spraying is delayed until egg-hatch has begun, flooding of the calyx cup or complete wetting of the truss is necessary to achieve success; best results were given when 0.025% di-octyl sodium sulphosuccinate was added as a wetter.

CITRUS RED SCALE

In the *California Citrograph*, Vol. 39, No. 11, 1954, pp. 379, 392, 394 to 395, A. W. Cressman and others state that in California kills of California red scale, *Aonidiella aurantii*, on citrus with sprays of parathion 1½ lb. per 100 gal. (150 *grm. per* 100 *litres*) vary according to the plant part infested. Kills 8 weeks after spraying lemon trees were 49% on fruit, 59% on green wood, and 87% on grey wood; on Valencia orange trees the respective kills were 62, 92 and 99%. Higher kills were obtained on mature fruit than on green oranges. These differences are the reverse of those found for oil sprays, and 1 lb. parathion + 1.8 gal. oil per 100 gal. (100 *grm.* + 1.8 *litres per* 100 *litres*) gave equal kills on all tree parts. Population density had little effect on kills. Young scales were more readily killed (100% at 15 days) than older scales (28% at 45 days).

INSECTICIDES NON-TOXIC TO SCALE PARASITES

In the *California Citrograph*, Vol. 39, No. 8, 1954, p. 297, B. R. Bartlett has reported that intensive testing in citrus orchards in California shows Aramite (2-(p-tert-butylphenyl)-isopropyl-2-chloroethyl sulphite) and Ovotran (parachlorophenyl-parachlorobenzene sulphonate) to be almost non-toxic to *Aphytis chrysomphali*, an external parasite of California red scale, to *Metaphycus helvolus*, an internal parasite of black scale, and to *Lindorus lophanthae*, a ladybird that feeds on hard scale insects.

TREATMENT AGAINST CABBAGE WHITE BUTTERFLY

In the *Agricultural Gazette of New South Wales*, Vol. 65, No. 4, 1954, pp. 182 to 184 and 208, J. G. Gellatley reports that complete prevention of severe infestation of the cabbage white butterfly, *Pieris rapae*, on cauliflowers was obtained in New South Wales by weekly spraying with 0.01% DDT emulsion or 0.0125% parathion emulsion and by weekly dusting with DDT (2%) + BHC (0.26% gamma isomer) ensuring that the undersides as well as the tops of the leaves were treated. Spraying with demeton as Systox 0.05% at intervals of 2 to 3 weeks was unsuccessful.

SPRUCE BUDWORM: PARASITE BUILD-UP

W. K. Coulter, U.S. Forest Service, reports in *Agricultural Chemicals*, Vol. 9, No. 7, 1954, p. 68, that in Oregon parasites of the spruce budworm (*Choristoneura fumiferana*) in an area of 3 million acres (1,215,000 *hectares*) survived spraying with DDT, and that they are now present in increased numbers and are more successful against the budworm than before spraying 3 to 4 years ago.

FUNGICIDES

TEA BLISTER BLIGHT

G. C. Denham states in *World Crops*, Vol. 6, No. 8, pp. 314 to 316, that in Indonesia successful treatment of blister blight caused by *Exobasidium vexans* was a major factor in rehabilitating tea gardens abandoned during the war. Crop losses of 25% were caused; treatment, costing about 3d. per lb. (0.45 *kg.*) of made tea, has reduced loss to a negligible amount, but losses of 15% are expected if treatment at present being carried out is relaxed.

TEA BLISTER BLIGHT

According to C. A. Loos in the *Bulletin of the Tea Research Institute* of Ceylon, No. 34, 1952, pp. 40 to 41, the increase in tea yield in Ceylon

by weekly spraying with ' Perenox ', 4 oz. per 10 gallons (25 *grm. per 10 litres*) at 12 gallons per acre (134.8 *litres per hectare*) was 26% over a period of 3½ years. Annual increases varied from 20% to 29%. Fortnightly spraying at the same rate gave an increase of 20%, varying from 16% to 25%. Fortnightly protection increased production of maintenance foliage and wood by 55% (weekly, 49%); without protection yield and maintenance growth were reduced by blister blight (*Exobasidium vexans*).

PAPAYA FOOT ROT CONTROL

According to R. S. Nirvan in *Indian Phytopathology*, Vol. 6, No. 1, pp. 47 to 48, application of Bordeaux mixture 6 : 6 : 50 is promising as a protective treatment of papaya foot rot caused by *Pythium aphanidermatum*. Soil was removed to a depth of 2 in., (5 *cm.*) and bole and soil thoroughly drenched before returning the soil. Three sprays at 20-day intervals were given commencing with the appearance of rains in July. In the second year two applications were made, this time adding 'Alboleum ' as a sticker to prevent leaching. Incidence was reduced from 35% to 2.5%.

CEREAL SEED TREATMENT: EFFECT OF WEEDS ON EFFICACY

According to J. E. Machacek in the *Canadian Journal of Agricultural Science*, Vol. 34, No. 3, 1954, pp. 240 to 251, field plot experiments show that cereal seed dressing against seedling blight (*Helminthosporium* spp.) is of limited value on weed-free land, though giving good returns on weed-infested fields. In the absence of weeds, the percentage germination of infested seed had little effect on yield owing to compensation for low germination by increased tillering of surviving plants: yields from thin stands were as good as those from dense stands; hence seed dressing was no benefit. But on weedy land (using rape to simulate weediness) compensation for low germination was prevented and yields were related to the number of plants, increases being greater at low rates of seeding; hence seed dressing was beneficial. This would not hold for seed infested with a virulent pathogen, such as a smut fungus. Fungicidal treatment is recommended for all seed of unknown health status, all seed severely injured mechanically, and all heavily infested with *Helminthosporium* spp. when destined to be sown on weedy land.

APPENDIX

The following chemicals mentioned in this issue are available in the 'Plant Protection' range of products for export under the trade names given below:—

BHC (Benzene hexachloride)

'Agrocide' insecticides, containing 2.6%, 6.5%, 10% or 13% BHC.

Lindane

'Gammalin' 20, containing 20% gamma BHC (Liquid).

'Gammalin' 50 D.P. containing 50% gamma BHC (Dispersible powder).

'Gammalin' Seed Dressing, containing 50% gamma BHC (Dry dressing).

DDT

'Didimac' insecticides, containing 5%, 25% or 50% DDT, available in liquid, dust, and dispersible powder forms.

Oilsprays

'Albolineum' ('Alboleum').

'Ovotran'

'P.P. Ovicide' Summer, containing 50% CPCBS (*p*-chlorphenyl *p*-chlorbenzene sulphonate). A dispersible powder.

Cereal Seed Dressings

'Agrosan' GN, 'Agrosan' 5, 'Agrosan' 5W, containing organo-mercurial salts, equivalent to 1% and 5% mercury respectively. The last of these is a slurry formulation.

'Mergamma' A, a combined insecticidal/fungicidal seed dressing containing organo-mercurial compounds equivalent to 1% of mercury and a substantial proportion of gamma BHC (lindane).

Copper fungicides

'Perenox', containing approximately 50% copper in the form of cuprous oxide. Used as a spray.

'Peremac', containing approximately 50% copper in the form of cuprous oxide. Used as a spray.

'Perecloud' 4, containing copper oxychloride equivalent to 4% copper. A dust.

Organo-mercury sprays

'Verdasan', containing organo-mercurial salts equivalent to 2.5% organically combined mercury.

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